## VELOCITY OF FALLING RAINDROPS.

In the American Meteorological Journal for September, 1887, 4:207, the late Prof. Henry Allen Hazen opposes the idea adopted by Prof. Joseph Henry and many others, that the gust blowing outward from a thunder-storm may be due to the air driven down by falling raindrops (in addition to the descent due to the density of the air cooled by the evaporation of the falling drops). The question of the velocity of the falling drop is therefore important in this connection, and has been newly considered by Dr. T. Okada,[1] of the Central Metorological Observatory, Tokyo, Japan.

Altho in nature we see a rapid series of changes going on by which large falling drops break up into small ones whose diameters are in the ratio 1:2:4:8, and altho we do not often observe the union of small drops into larger ones, yet Okada adopts the idea worked out mathematically in W. H. Besant's Treatise on Dynamics, 3d edition, 1902, p. 78, that the falling drop receives continually accessions proportional to its surface area; he also adopts $C = 0.204$ as the constant for the air resistance and deduces the following table of resulting velocities in meters per second.

TABLE 1.—*Velocities of falling raindrops.*

| Distance fallen. | Diameters of drops. | | | |
|---|---|---|---|---|
| | 1 mm. | 2 mm. | 3 mm. | 4 mm. |
| *Meters.* | *M.p.s.* | *M.p.s.* | *M.p.s.* | *M.p.s.* |
| 1,000 | 3.1 | 3.5 | 4.0 | 4.4 |
| 1,500 | 3.6 | 4.0 | 4.4 | 4.8 |
| 2,000 | 4.0 | 4.4 | 4.8 | 5.1 |
| 2,500 | 4.4 | 4.8 | 5.1 | 5.4 |
| 3,000 | 4.8 | 5.1 | 5.4 | 5.7 |

—*C. A.*

## WIRELESS TELEGRAPHY IN THE SERVICE OF MODERN METEOROLOGY.

### RESULTS OF INVESTIGATIONS MADE DURING A TRANSATLANTIC VOYAGE IN AUGUST, 1908.

By Dr. P. POLIS, Director of the Meteorological Observatory of Aachen (Aix-la-Chapelle). Dated Aachen, October 22, 1908.

[Translated by C. Fitzhugh Talman, Librarian, Weather Bureau.]

The first attempts to utilize wireless telegraphy for the benefit of the weather service were undertaken in 1904 by the London Daily Telegraph, and led to a discussion of the subject at the International Meteorological Conference at Innsbruck, 1905. The matter was brought before the Conference and a report on the subject presented by the writer of this article. The question was referred to the International Meteorological Committee.

Experiments in this line have likewise been carried on by the British Meteorological Office, under the direction of Doctor Shaw, with the use of observations taken on board British warships. The United States Weather Bureau, also, made use some years ago[1] of such reports from vessels on the Atlantic, to enlarge the scope of its weather maps.

Last year I paid a visit to the United States, in the course of which I made some preliminary investigations regarding the transmission of weather reports at sea. These investigations were continued on a larger scale in August of this year during a voyage to America and return on board the *Kaiserin Auguste Viktoria*, from the 7th to the 27th of August. Not only were weather telegrams sent from ship to ship, but wireless reports containing meteorological data were also received from land stations in Europe and America; the former viâ the Marconi station at Clifden, the latter viâ Cape Cod. All steamers passing within range of the *Kaiserin* were requested to communicate meteorological observations taken during the preceding twenty-four hours. These observations were secured thru an understanding most obligingly entered into by the other steamship companies with the Hamburg-American Line; and the telegrams were transmitted free of cost by the Marconi company. These telegrams contained the position of the ship, time, height of the barometer, temperature of air and water, and wind direction and force. Generally as many as five reports from vessels were available daily. Moreover observations from stations on the British and French coasts were forwarded daily from the observatory of Aachen, by way of the Marconi station at Clifden, for four days after the ship left Cherbourg, i. e., to a distance of about 3,000 kilometers (1,864 miles) from the British coast. The telegrams, tho in cipher, were transmitted to this distance with absolute accuracy. A copy of one of these telegrams, that of August 11, is given below, accompanied by the translation:

Compagnie de Télégraphie sans Fil.

11 August 1908. Marconistation *Kaiserin Auguste Viktoria.*

Aufgabestation: Aachen.

Aufgenommen 43° N. Br. 45° 37′ W. L. 1640 Meilen von Scilly entfernt.

An POLIS:

62613 263 63126 64526 70928
68930 69532

*Translation.*

Aachen, 762.6, 13°, WNW., 3; Stornoway, 763.1, WNW.; Malin Head, 764.5, WNW; Valencia, 770.9, NW.; Scilly, 768.9, NNW.; St. Mathieu, 769.5, N.

The Central Office of the United States Weather Bureau, at Washington, very obligingly furnished, at my request, observations at stations on the American coast for the last days of the outward journey and the first two days of the return journey, thru the Marconi station at Cape Cod.

The material received was brought together in the form of a weather map, (see Chart IX), and it was found possible to make a map every day on both the outward and the return journey. Thus on the weather map of August 11 (Chart IX, fig. 2), when wireless telegrams from Clifden were still being received at longitude 45° west, observations from the French and British coasts were charted, and there were also five observations from vessels. The map shows a high-pressure area extending from France to the Azores, a low near Iceland (see Chart IX, fig. 1), and a second low in the neighborhood of the Newfoundland Banks. The latter moved eastward and crost the track of the *Kaiserin* in the following night, bringing cloudiness, rain, and strong southwest winds. The weather map of August 22 (Chart IX, fig. 4), made on the homeward journey, extends from eastern America to 30° west longitude. It shows the state of the weather for a distance of 800 miles from the *Kaiserin*, as it was possible to utilize the observations of several west bound ships. This map shows a depression between 40° and 30° west longitude, in which the steamers *Kronprinzessin Cecilie* and *Germania* had stormy west winds. This depression moved eastward, while a high-pressure area accompanied the *Kaiserin* from the United States as far as the middle of the Atlantic Ocean.

[1] Journal of the Meteorological Society of Japan, August, 1907, p. 1.

[1] The Weather Bureau work in wireless telegraphy began in January, 1900, when R. A. Fessenden was employed to carry out the instructions of the Chief of the Bureau. The development of the Weather Bureau system was subsequently relinquished; but the receipt of daily wireless messages from ocean vessels for use in compiling weather maps and forecasts began December 3, 1905. (See Monthly Weather Review, 1906, 34: 609-10.) Before July 15, 1902, the Marconi station on Nantucket was transmitting, via Nantucket Shoals Lightship, the regular Weather Bureau daily forecasts to such Cunard Line steamers as requested it.

The current condition of our experience is summarized in the Annual Report of the Chief of Bureau, which will appear in our Annual Summary for 1908.—*C. A.*

In addition to the daily determination of the weather situation and the making of weather charts, certain other meteorological investigations were carried on; viz, regular observations of temperature and humidity with the aspiration psychrometer. These had the remarkable result of indicating an excessive dryness of the air in the presence of a high-pressure area. The following observations were made on August 21:

| Time | Latitude, North. | Longitude, West. | Air temperature. | Absolute humidity. | Relative humidity. | Water temperature. |
|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | °C. | *Mm.* | % | °C. |
| 8 a. m. | 40 26 | 67 21 | 18.3 | 9.1 | 52 | 18.4 |
| 12 noon. | 40 38 | 65 34 | 21.0 | 7.6 | 30 | 25.3 |

From the above it may be seen that on that day the air was exceedingly dry, both with a low and a high water-temperature. The mighty reservoir of the Atlantic Ocean was almost without effect on the condition of the air; and the explanation of this fact is to be found in the strong descending currents of the high-pressure area, an explanation confirmed by the extraordinary clearness of the air on that day. These observations were an indication that the *Kaiserin* was not running into the low to the eastward. (See Chart IX, fig. 3.)

On August 27, just before we entered the English Channel, the weather map was finished by about 1 p. m. On this day a severe cyclonic storm lay over the North Sea. About three hours were required for the transmission of the telegrams from the observatory at Aachen, by way of the Marconi station at Crookhaven.

Thus for the first time during the entire voyage of a steamer, have the surrounding weather conditions been followed and weather maps made on the basis of direct observations transmitted by wireless telegraphy from both ships and shore stations. Also, both on the outward and home journey, so long as the *Kaiserin* was in communication with the English coast observations were forwarded from the ship to the observatory at Aachen. The shortest time of transmission for the latter message was 2 hours and 45 minutes.

At a meeting of the administrative board of the Public Weather Service, held at Hamburg October 1, the use of wireless telegraphy in meteorological work was the subject of a lively discussion, and the author laid before the meeting, at which were present representatives of the Imperial Ministry of the Interior, the Post Office, and the Ministry of Marine, both the telegrams received during the voyage and the original weather maps made on shipboard, together with the "Internationale Dekadenberichte" [of the Deutsche Seewarte] for August. A special committee was appointed, charged with making preparations for a further investigation of this subject. The committee is composed of a representative of the Deutsche Seewarte, the Director of the Royal Prussian Meteorological Institute (Doctor Hellmann), Director Polis of Aachen, and representatives of the Hamburg-American Line and the North German Lloyd Company.

To what extent wireless weather reports from the ocean would be of service to practical meteorology in Europe only the future can determine, but that they would be of great value can hardly be doubted. This year's investigations at sea have at least proven that the transmission of such reports is safe and sure, and also that it is feasible to make [daily synoptic] weather charts on the ocean itself.

---

In connection with the above paper it is only proper to state that some of the European meteorologists are not so sanguine as Doctor Polis regarding the benefits to be derived from wireless reports, whether for use on shipboard or for the land forecasts of western Europe. An especially pessimistic view of the matter is exprest by Dr. E. Herrmann, of the Deutsche Seewarte, in the nautical magazine Hansa, of September 26, 1908.

The experience of the British Meteorological Office in dealing with wireless reports from naval vessels is, on the whole, encouraging, but emphasizes the necessity of a careful control of the barometer readings thus received. The investigations of Mr. Ernest Gold appear to show that barometer readings on board ship are generally too low in strong winds.[2]

Beginning with February, 1909, a series of tests of the efficiency and utility of wireless weather telegraphy, extending over a period of three months, will be carried on jointly by the Meteorological Office and the Deutsche Seewarte. It is understood that arrangements have been made whereby all the principal transatlantic steamship lines will forward wireless weather reports to the above-named offices. The results of these experiments are to be presented to the International Commission on Weather Telegraphy, which meets in London June 21, 1909.—*C. F. T.*

---

## REMARKABLE SNOW-STORM AT GRAND HAVEN, MICH.

By C. H. ESHLEMAN, Observer. Dated Grand Haven, Mich., November 20, 1908.

A very remarkable snow-storm occurred at Grand Haven, Mich., on November 14, 1908. Between about 1 a. m. and 6 p. m., 12.5 inches of snow fell. This is by far the heaviest 24-hour fall in November on record here, and was exceeded only once in any other month, viz, on January 22–23, 1898, when 13.6 inches fell. The snowfall records at this station began with the season of 1889–90 and extend to the present time, except for the period July 1, 1903, to August 1, 1905, when the regular Weather Bureau station had been discontinued. The rate of fall in the recent snowfall was very large, the average rate from about 3 a. m. to 1 p. m. being about 1 inch per hour.

But remarkable as the snow was in its amount, it was no less remarkable for its limited and well-defined extent. It covered a strip of country that extended inland only about 15 or 20 miles, and along the lake for a distance of about 70 or 80 miles. The greatest falls occurred 6 or 7 miles from the lake, beginning a little south of Grand Haven, and extending northward 20 or 30 miles. Along this line depths of 16 to 18 inches were reported. Beyond the limits first mentioned the amount decreased rapidly, so that 15 or 20 miles farther on the depth was rarely more than 1 or 2 inches, and in the majority of cases even less. Fishermen who were out on the lake 15 or 20 miles from shore report that very little snow occurred there.

Grand Haven appears to be located about midway between the northern and southern extremities of the area. At Ludington and St. Joseph, to the northward and southward, respectively, but beyond the limits the amounts were very small. None of the other Weather Bureau stations in the Lake region reported more than 1 or 2 inches, some of them only a trace.

It may be said that the particular section covered by the snow has a nearly southwestward exposure to the lake, and beyond the limits defined the trend of the shore changes somewhat. The general direction of the winds over Lake Michigan during the storm was southerly to westerly. At Grand Haven, however, the direction was somewhat variable, being southeasterly most of the time, occasionally shifting to southwesterly. About noon it shifted to westerly, and after that the rate of fall diminished gradually.

It is possible that the intermixture caused by the varying wind direction, of masses of air having different moistures and temperatures was a potent factor. There were no marked local changes in temperature or pressure. The phenomenon appears interesting as an extreme instance of the effect of a peculiar lake exposure on the weather of particular localities.

---

[2] "Comparison of ships' barometer readings with those deduced from land observations; with notes on the effect of oscillatory motion on barometer readings." (Q. J. R. Meteor. Soc., April, 1908, p. 97–108.)